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Development of assimilation schemes for the representation of dust in LAPS and WRF modeling systems based on MODIS and MSG satellite retrievals

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Dust is the most abundant aerosol worldwide with multiple implications for radiative transfer, cloud processes and air quality. The dust emissions are usually represented in atmospheric models based on static dust source maps and surface wind properties. In operational dust forecasts, the models are commonly configured in warm start mode, meaning that each simulation cycle is initialized by the forecasted dust fields of the previous run. This technique inevitably inserts certain amounts of uncertainty due to the deviation of numerical solutions. In this study we present the development and evaluation of alternative methods for the initialization of dust emissions in the Georgia Tech Goddard Global Ozone Chemistry Aerosol Radiation and Transport of the Air Force Weather Agency (GOCART-AFWA) module of WRF model. First, we implement a time-varying dust source map based on the 16-day average Normalized Difference Vegetation (NDVI) from the MODIS-Terra instrument. Replacing the static dust source map with a dynamic satellite-based emissions map, allows a physically based representation of seasonal and annual variations of initial dust-source strength in the model. Second, we demonstrate the assimilation of dust Aerosol Optical Depth (AOD) satellite retrievals from the MSG/SEVIRI sensor in the Local Analysis and Prediction System (LAPS), for use in WRF model. A 3D-Var assimilation of satellite AOD retrievals from the MSG-SEVIRI instrument is performed in LAPS, similar to the standard assimilation of atmospheric variables. The forecasted WRF dust AOD is used as first-guess field for the generation of the assimilated AOD in LAPS. Finally, the LAPS AOD is used to initialize the WRF simulations, thus nudging the model towards the observational satellite values. Model runs with different configurations of the MODIS-NDVI and MSG-SEVIRI assimilation schemes are performed for the region of North Africa and the greater Mediterranean. First results verify the successful implementation of both assimilation parameterizations in WRF-Chem. The improvements and deviations between the original and the newly developed schemes in GOCART-AFWA are discussed in comparison with the AERONET station measurements of AOD.

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